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14. ABSTRACT

The primary objective of this research effort is to integrate ViTel Net's MedVizerTM software and Dvision Tools with cross platform telemedicine systems, inclusive of computer based systems, handheld wireless PDA devices, and miniature computers, to existing DoD legacy and developing healthcare information systems, clinical repositories, and knowledge base systems for application at the point of care. This annual report reflects a number of projects wherein the tasks defined in the SOW are being accomplished. Specific project reports referenced herein detailing the specific application, work progress, and results will be submitted as supplementary reports.

15. SUBJECT TERMS
Telemedicine, Patient Distributed Record, Medical Infomratics, Point of Care, Knowledge Acquisition, Wireless Information Technologies

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TITLE: Secure Wireless Military Healthcare Telemedicine Enterprise System

INTRODUCTION:

The emerging nature of telemedicine is an environment in which health care providers seek to share a vast array of medical information which is captured, disseminated, and displayed in a variety of modalities ranging from email to high resolution imagery and real-time video teleconferencing. In theory clinicians should be able to select and use the information modalities and electronic medical record systems they prefer, with the technical systems integration issues of information discourse among disparate sources being transparent.

The overall research and development goals of the Secure Wireless Military Healthcare Telemedicine Enterprise System research effort is to evaluate the use of ViTel Net's MedVizer Dvision Tools; a commercial-off-the-shelf (COTS) telemedicine integration tool for rapidly configuring and dynamically integrating disparate medical teleconsultation systems, medical information and image display modalities, and electronic medical records systems. These tools span the continuum of the Defense Health System from the foxhole to the medical center in a secure environment.

The objective is to demonstrate the use of the MedVizer Dvision Tools—a telemedicine information integration software product—for the rapid configuration of wireless and wired teleconsultation systems with legacy and emerging Department of Defense health informatics systems without need of additional conventional programming or costly systems integration efforts. Critical to the integration process is the maintenance of security requirements while operating across the spectrum of communications systems supporting the Medical Operational Continuum from the front line Medic to the fixed facility Medical Centers.

BODY:

Throughout the research process, ViTel Net remains focused upon the following development guiding principles:

- Focus on the full spectrum of the Continuum of Care
- Minimize training and technology challenges and enhance data portability through cross-platform products and services
- Provide complete, up-to-date patient information throughout the Continuum of Care
- Incorporate the most appropriate current technology while remaining flexible to technology changes
- Achieve better outcomes through integrated data fusion

The initial concept for the research plan as described within the Statement of Work was that each task, although related, would be able to be performed as individual tasks. As the execution of the plan began it was quickly realized that several factors, described below, were impacting on the planned approach making it difficult to execute and limiting productivity.

- Many of the tasks were dependent upon the availability and access to the military's legacy and emerging health information systems, access to clinical areas within selected military facilities, and access to point-of-care medical personnel at various points across the military's operational health care continuum.
- The need to continuously adapt to the dynamics of technological changes occurring both in the biomedical and information technology fields.
- The realization that the most appropriate and productive means of accomplishing the tasks was to identify specific meaningful projects in which there was support either within a military or civilian healthcare facility that would involve the performance application of task objectives and goals and the same time provide a means for test and evaluation.

These factors have led us to the adoption of a research approach that is responsive to project opportunities within the general context of the research design and that will ensure timely and productive task accomplishments.

This revised approach continues to enable ViTel Net to apply the planned research methodology as described in our proposal—including computer modeling and simulation—followed by prototype development and bench testing. Following a successful bench test, the prototype is introduced into a "live" environment where it can be integrated with an existing medical informatics system for data retrieval and input process testing. The final step will be the introduction of the integrated device into field and clinical settings for testing and evaluation.

The research project from conception was projected as a four-year project. The research and development methodology that serves to guide the project is a four-step process, corresponding to the project year, as follows:

- **<u>Step 1: Concept Formulation</u>** – During this period effort was devoted to defining requirements, conducting preliminary analysis, developing the initial problem solution approach, and formulation of the design concept.
- **<u>Step 2: Laboratory Development</u>** – Work during this period is focused to the design and building prototype models, prototype testing within a "sterile" laboratory environment, and refining the prototype model based upon the results of the laboratory test.

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- **Step 3: Field Application** – Prototype models will be subjected to field applications were limited test are conducted. Results of the test are applied and compared with the design objectives, and necessary engineering and design modifications are applied to the prototype design.
- **Step 4: Clinical Demonstrations** – Targeted clinical demonstrations will be conducted within a controlled environment to enable a more robust comparison with stated objectives and actual outcomes as well as user adaptation. These results will enable the final engineering changes in preparation for clinical trials.

The many variables impacting on the research and development effort, some of which are described above, have precluded our efforts to precisely follow the steps and time sequence as initially planned. In an effort to take advantage of opportunities both within the military and commercial sectors, development of component attributes that would lead to the research objectives were undertaken and moved forward Others were delayed in an effort to develop the clinical concept necessary to precisely describe requirements that forms the cornerstone of the research methodology.

This report therefore should be viewed as an interim report which addresses each of the specific tasks specified in the SOW and provides a brief overview of projects that have been completed or that are in progress related to the respective research tasks. Subsequent reports will be developed for each specific project describing the concept, research approach, integration and development activities, and results of implementation and evaluation.

Task 1: Continue to demonstrate that a COTS medical information system tool (MedVizer^{TM}) facilitates rapid integration and implementation of teleconsultation systems within military treatment facilities.

The MedVizer^{TM} Tools were redefined and expanded into a more comprehensive COTS based Informatics Integration Platform consisting of a core set of functionalities that enable the rapid integration of medical information systems, medical sensing devices, medical imaging devices, and secure data devices that are used across the operationally defined continuum of care. The need for the seamless integration of systems that would enable the interaction of patient to physician and physician-to-physician to facilitate rapid response to healthcare needs was essential. The MedVizer^{TM} Informatics Integration Platform (MIIP) provides the tools necessary for such integration.

The following graphic shows the MedVizer^{TM} Informatics Integration Platform:
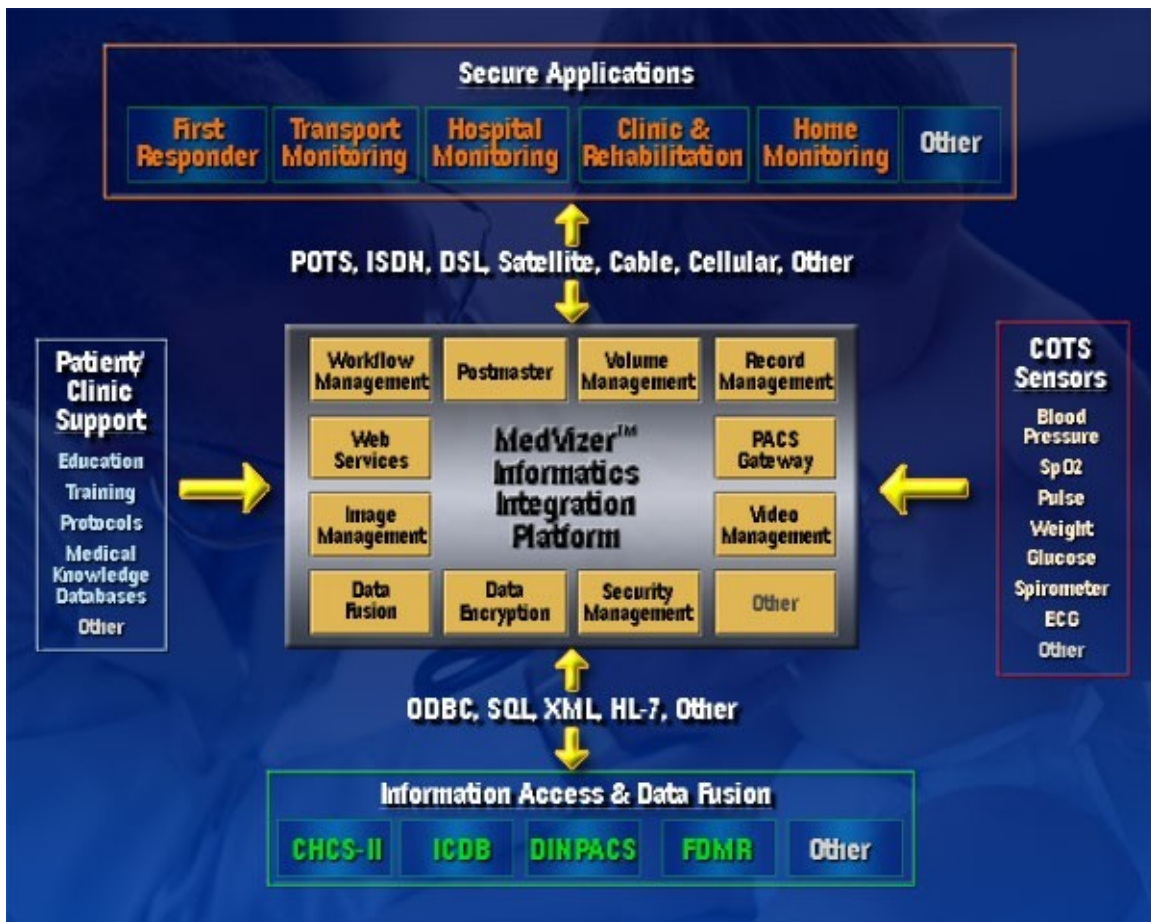
The MedVizer Informatics Integration Platform has been demonstrated to facilitate rapid integration and implementation of teleconsultation systems within military treatment facilities, including the following:

Walter Reed Army Medical Center OB-GYN
The OB-GYN Clinic at Walter Reed Army Medical Center (WRAMC), seeking to reduce the time and cost involved in intake interviews for their outpatient service, provided an opportunity to address data collection and data entry requirements at a different level of care. The desired objective was to automate the patient registration and intake interview process using wired and wireless technology to replace the traditional labor-intensive process currently used. It was determined that an integrated system that would provide the means whereby a patient can automatically access their record, update the record with their current vital signs (blood pressure, pulse, temperature and weight), and complete an intake questionnaire describing current physical condition–without any intervention by hospital personnel. The patient's record to be immediately updated within the legacy hospital information (Composite Health Care System I [CHCSI]) using an ICDB interface, and be available to the attending physician for review prior to seeing the patient. Therefore, transfer of data from the intake station to the CHCSI database must occur in real-time. The goal of the process is to eliminate the traditional labor-intensive method of obtaining patient information and of the manual data entry into the hospital

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information system.   The project was undertaken in phases to accommodate the clinical process and to insure interoperability with the legacy HIS system.

This project accomplished the following objectives:

- Evaluates the efficacy of patients' participation in the capture and charting of vital signs and health outcomes assessments.
- Automate the check and registration functions, freeing up medical staff to provide better medical care.
- Leverage legacy systems by extending their ability to control vital sign devices, while automatically collecting this information without human intervention.
- Evaluate medical devices and protocols that can be utilized by patients to provide valuable information in the care delivery process.

The project was conducted in two phases to accommodate the clinical process and to insure interoperability with the legacy HIS systems. The MedVizer Informatics Integration Platform enabled this rapid development, testing, prototyping, and enhancing iterative process.

The initial phase involved:

1) Assessing the vital sign data sets that needed to be electronically entered into the patient record and
2) Using MedVizer MIIP to build an XML interface to the ICDB
3) Implementing a transaction bridge from the ICDB interface to CHCSI

The second phase involved:
1) Integration of the electronic registration.
2) Integration of the patient intake questionnaire to be developed using the MedVizer MIIP
3) Integration of the data to the patient record contained in CHCSI.

Phase I completed. During this phase the patient identification information was manually entered and sent to the ICDB Healthy Forces database to retrieve or gain access to the patient record. In the event it is a new patient, a new record was created using the system. Patients updated their record by using the electronic vital signs monitor located in the Kiosk. The acquired data, without further intervention was transmitted to the patient record residing in the ICDB database. ViTel Net, with this conceptual framework, completed the model design for the user interface and technology workflow. Using the MedVizer tools an XML interface to the ICDB was developed to enable the transaction for updating the patient record in the legacy hospital information system. A demonstration was conducted including the retrieving of a patient record adding current data and sending it to ICDB through the XML interface to populate and update the data base record

Phase II completed.

The user interface must enable the patient, with limited instructions, to use bar code technology to access their record simply by swiping their military identification card. Upon accessing and verifying that their record is correct the patient then must be able to electronically gather their vital signs, using the electronic vital signs medical device for blood pressure, pulse and temperature, the results are then automatically updated in the patient's record. The patient then will step on the electronic scale; those results will also be automatically updated in the record. Upon verifying that all fields have been completed the patient will exit their record, which will clear the system of all data. Upon exiting the system it will automatically update that patient's record in the ICDB Healthy Forces. The record is immediately available for review by the attending physician with all data updates.

The user interface and instructions were evaluated for ease of use prior to submission to the WRAMC project personnel for comment and approval. Concurrently, ViTel Net's engineers and WRAMC information technology team assigned to the project are exchanging necessary data to enable the integration of the XML interface to the ICDB for accessing patient records stored in that legacy hospital information system. This interface was tested in a laboratory environment using a simulated ICDB database provided by WRAMC.

1) The patient swipes their military identification card using ViTel Net's integrated card reader technology that automatically initiates a transaction to retrieve or gain access to their record. In the event it is a new patient, a new record was created using the system.
2) Patient intake questionnaire was developed in coordination with the clinical medical staff. The questionnaire was integrated into the intake process user interface using the MedVizer MIIP. The questionnaire was developed to provide the user a choice of responses using a response tree format for example, do you drink alcohol? If the answer is yes the system automatically ask the next question concerning number of drinks and type of alcoholic beverage. If the answer was no, the system automatically took the patient to the next question, perhaps concerning smoking. This approach was tested with the MedVizer database. The question response format was modified based upon medical clinic review and re-tested.
3) Integration of the questionnaire with ICDB Healthy forces using an XML was developed using the MedVizer MIIP. At this point it was determined that Healthy Forces did not contain all the fields corresponding to the questionnaire and therefore the transaction could not be completed. The questionnaire was modified to contain only those questions that corresponded to those in Health Forces. With this modification the data was successfully transferred using the XML interface.

Task 2: Integrate ViTel Net's Wireless MedVizer^{TM} Telemedicine Systems, to include the Medical Personal Digital Assistant MPDA, to achieve interoperability with DoDs legacy and emerging Hospital Information Systems and electronic medical record.

In addition to the ongoing work to interface with the ICDB and CHCSI discussed above, ViTel Net has used the MedVizer MIIP to successfully establish connectivity to the following DoD health care information systems:

   a. Integration with legacy hospital information systems HIS and electronic medical records systems:
      (1) CHCSII
      (2) CHCSII Theater
      (3) FDMR (field version)

   b. Integration with medical imaging systems & standards:
      (1) DINPACS
      (2) DTS
      (3) DICOM
      (4) JPEG
      (5) MPEG
      (6) H.323 VTC

   c. Integration with portable DoD record devices:
      (1) USAMRMC multimedia personal information carrier (PIC)
      (2) DOD CAC card
      (3) Standard bar code strips

   d. Integration with the Veterans Administration (VA) VISTA HIS system has been completed and testing is on-going. The VA "home monitoring" program is designed to enable home bound patient, using the ViTel Net Turtle Product to acquire vital sign information and to respond to a series of questions concerning the status of their health condition. The data is transmitted using standard telephone lines to the MedVizer PostMaster Database Server located at the VA National Center. The data is received processed and the patient record is updated with current information. Currently the respective VISN clinical team accesses the MedVizer central database using a web browser interface. ViTel Net has developed the HL7 interface to enable the data received by the MedVizer PostMaster database to be forwarded to the VA VISTA database. Preliminary testing has been completed. Lab testing is currently ongoing at the VA.

   e. Integration with Commercial Hospital Information Systems: HL7 interface has been developed using the MedVizer MIIP with two commercial HIS systems, Cerner Beyond Now, Nemours EPIC. Both interfaces have been completed and are currently used in actual application.

<u>Task 3: Demonstrate interoperability of ViTel Net's Wireless MedVizer^{TM}</u>
<u>Telemedicine Products with the Air Fortress Technology's Air Fortress</u>
<u>802.11b security system.</u>

The design configuration and work plan for implementation of the OB-GYN Outpatient Clinic, Walter Reed Army Medical Center (WRAMC), continued from Task 1, has been completed and agreed upon by all participating WRAMC agencies/departments.

In a parallel process ViTel Net completed the integration of a prototype system. During the preliminary testing of the prototype it was determined that a wireless (802.11b) security system would need to be integrated prior to implementing within WRAMC. ViTel Net's Wireless MedVizer Telemedicine Products were integrated and tested using the Fortress Technology's Air Fortress 802.11b security system" was advanced. Interoperability testing with Air Fortress 802.11b security system in a laboratory environment with a variety of MedVizer Telemedicine Products has been completed.

ViTel Net's MedVizer and MedVizer Informatics Integration Platform interoperability with the Army Medical Material Command accepted system, Air Fortress, was demonstrated. However, WRAMC uses the Cranite security system. Because ViTel Net was field testing at WRAMC, ViTel Net performed the same security and interoperability tests with the Cranite security system. MedVizer and MedVizer Informatics Integration Platform interoperability with Cranite was demonstrated during these tests.

There were no compatibility issues identified in the testing environment. The test did not, however, evaluate the level of security afforded by the Air Fortress technology but rather that interoperability between that system and MedVizer products. The test environment validated full compatibility without any degradation in quality of performance of the MedVizer products.

The user interface must enable the patient, with limited instructions, to use bar code technology to access their record simply by swiping their military identification card. Upon accessing and verifying that their record is correct the patient then must be able to electronically gather their vital signs, using the electronic vital signs medical device for blood pressure, pulse and temperature, the results are then automatically updated in the patient's record. The patient then will step on the electronic scale; those results will also be automatically updated in the record. Upon verifying that all fields have been completed the patient will exit their record, which will clear the system of all data. Upon exiting the system it will automatically update that patient's record in the ICDB and CHSCI (now a prototype data base). The record is immediately available for review by the attending physician with all data updates.

The user interface and instructions are being evaluated for ease of use prior to submission to the WRAMC project personnel for comment and approval. Concurrently, ViTel Net's engineers and WRAMC information technology team assigned to the project are

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exchanging necessary data to enable the integration of the XML interface to the ICDB for accessing patient records stored in that legacy hospital information system. This interface will be tested in a laboratory environment using a simulated ICDB database provided by WRAMC. It is anticipated that Phase 1 of this project will be ready for clinical trails at WRAMC later this calendar year assuming that all necessary WRAMC approvals are granted in a timely fashion.

Task 4: Integrate ViTel Net's MedVizer Telemedicine systems, to include the Medical Personal Digital Assistant (MPDA), with security protocols (HIPAA, digital certificates, ellipectic curve encryption)

MedVizer^{TM} Informatics Integration Platform provides an effective security architecture combining an authentication / privilege access model, windows application policies, data secure in transmission, data secure at rest, and watch Dog tools for auto logoff and data cleanup.
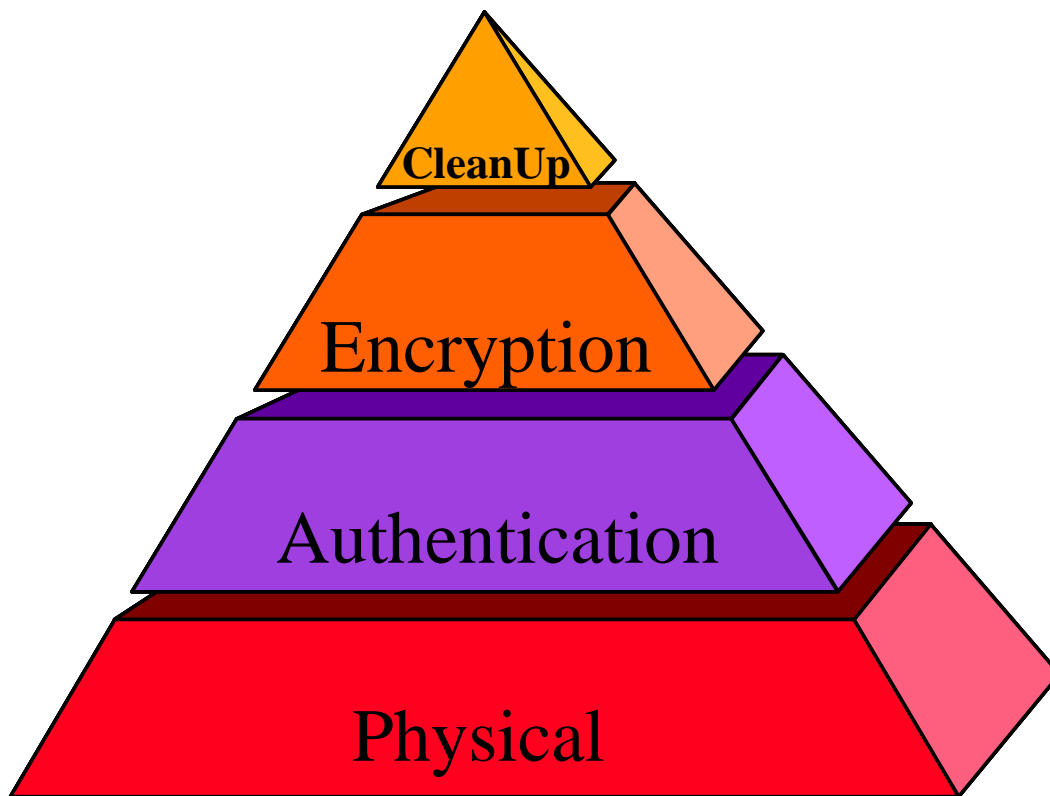
ViTel Net's four-tier security model

Today's systems must be equipped to accept manage and distribute information from a variety of sources. During our integration activities, ViTel Net identified the following security tollgates:

Identification

Today's systems must be equipped to accept manage and distribute information from a variety of sources. Flexibility and adaptability are the key avenues to success. The MedVizer^{TM} Informatics Integration Platform use authentication to combine identification with personal knowledge (password /pin) providing a very effective means for securing equipment, application access, and data.

ViTel Net's MedVizer^{TM} Informatics Integration Platform was evaluated and successfully provides the following methods of identification:
- Military ID Personal Information Carrier.
- PIC with access policies•- ViTel Net investigated a wide variety of flash disks, USB memory keys of varying capacity to be used as transport devices for the PIC. We successfully placed our encrypted medical record on each PIC device tested.
- Unique PIN / Password Linked to access controls.

Acquisition

ViTel Net's MedVizer^{TM} Informatics Integration Platform was evaluated and successfully provides security for the following types of data:
- Audio
- Vital Signs
- NIBP, SPO2, Pulse, Temperature, Blood Glucose, ECG, Weight
- Multimedia
- X-Ray, Ultrasound, Echocardiograph, Etc.

The following methods of secure data transmission of were tested. Applications developed with the MedVizer^{TM} Informatics Integration Platform provided effective security across the following methods:
- Wireless (Bluetooth, 802.11b)
- Wired
- Continuous data streams
- •Timed / event driven data transmission

During our integration activities, we identified some difficulties testing of sensor acquisition methods. These difficulties included the following:
- Device can easily loose their Bluetooth connection
- Bluetooth devices can easily loose their configuration settings
- Bluetooth devices can not be easily transferred from one processor to another
- Wired sensors can create a cable management problem

Some best practices learned from our integration activities include the following:
- Data acquisition and distribution frequency must remain flexible

- Integration of sensor data with video data is the best method of ensuring patient data integration

Abnormality Alerting is required in a data rich health monitoring environment

Medical Record Distribution
The following mechanisms of secure data transmission of were tested. Applications developed with the MedVizer^{TM} Informatics Integration Platform provided effective security across the following mechanisms:
- Personal Information Carrier – PIC
- Secure Message Basket
- Secure XML

Integration / Fusion
The MedVizer^{TM} Informatics Integration Platform provided effective security when integrating with the following databases:
- CHCS-II / ICDB (Oracle)
- DINPACS – DICOM 3.0
- ODBC
- Nemours EPIC System
- Cerner's Beyond Now System

Collaborative Methods
The MedVizer^{TM} Informatics Integration Platform provided effective security when used with the following collaborative methods:
- –Interactive Multimedia Conferencing
- –Store and Forward Multimedia Conferencing
- –Continuous Monitoring With Real-Time Data Overlay

With ViTel Net applications (to include the Medical Personal Digital Assistant), physical security is accomplished using policies and cyberkeys. Authentication combines identification with personal knowledge (password /pin) providing a very effective means for securing equipment, application, and data.

Task 5: Applications for Homeland Defense (Needs Analysis)

ViTel Net in coordination with Walker Baptist Hospital (Jasper, AL) and the Jasper, AL emergency response team developed a concept plan for implementing a telemedicine program that would contribute to the delivery of healthcare on a daily basis for Jasper residents. The design had to have the capability to be rapidly re-configured and be integrated with the Jasper emergency response team in the event of a mass casualty event, resulting from either natural or man-made events. The design also had to have an

interface with the DoD legacy HIS, CHCSII or ICDB – Healthy Forces. Several phases were involved in this project.

> Phase 1: A series of meetings were conducted with representatives of the hospital and the community emergency response team to gain understanding of current workflow and relationships, communication infrastructure and compatibility among agencies, and the type of telemedicine systems that needed by each agency.
>
> Within the community emergency response team and hospital there was no common communications infrastructure other than the standard telephone. Several alternatives were considered to address this issue. It was determined that the by establishing a central database using the MedVizer PostMaster Database configuration all data from each agency, in reference to a person or location, would be collected using various data gathering instruments. The data would be available to each agency by accessing the database through DSL connection. In the future a web interface would be developed for use.
>
> It was also agreed that four telemedicine applications were needed. First a small compact unit for use by the first responder is needed to gather patient/location information and to obtain vital sign information at the point of casualty and to transmit that data wirelessly to the MedVizer PostMaster Database. Emergency medical and fire department personnel would use this First Responder system. The second requirement was for a capability that would enable continued transmission of data during the evacuation process. This device would be designed for mounting in an ambulance and in air evacuation vehicles. The system would enable the medical team to continue to monitor the patient and transmit data to the central database. The addition of voice annotation and still image capture would be included in this configuration. Since patients would be evacuated to the nearest medical facility, local hospitals and medical centers, a third system was needed that would enable connectivity to the larger regional hospital and other tertiary hospitals within the Baptist Hospital Group. This system would be used primarily in the emergency room of these facilities with connectivity to trauma specialist at other locations. The system would be specifically designed for Trauma applications and would have access to the central database, provide means for continuous monitoring of vital signs and integrated live video connectivity. It was also believed that in a mass casualty event that schools, churches, recreation centers and other public facilities may be used as patient collection points. A fourth system for use in patient collection centers was needed. The system had to be small compact and enable the collection of vital sign data, still image transfer, voice and graphic annotation on images, and interactive video conferencing. This system had to be adaptable to available communication circuits to include; standard telephone circuits (POTs), DSL, and cable.

ViTel Net and SINTEF on a related TATRC contract developed or in the process of developing two of the four products, First Responder and Evacuation Telemedicine products. These two products, not developed as a part of this contract, were however used to demonstrate capabilities and products to Walker Baptist Hospital and the community emergency response team and are thus briefly described in this report.

ViTel Net leveraged previous work and the integration capabilities of the MIIP to develop and integrate the other two products for use at a Community Emergency Collection Center and by Trauma Specialist in local and regional hospitals. ViTel Net's suite of products to enable trauma specialist to immediately become involved in monitoring the patient's condition and directing treatment from the point of incident or casualty through the evacuation process to the trauma center and beyond. These products were developed for use to provide early intervention, the critical first minutes, by trauma specialist from the point of recovery through the evacuation process. Specialized intervention beginning at the time the medic encounters the casualty enhances stabilization of the patient and enables the trauma team to be prepare appropriately treat the patient upon arrival at the trauma center. Trauma specialists at tertiary level facilities have the capability to continuously monitor the patient's condition and to provide guidance as the forward trauma team administers emergency care.

MedVizer First Responder System

ViTel Net's MedVizer First Responder, developed as part of the US/Norway Contract, is designed to provide the medic at the scene to immediately collect, transmit, and disseminate vital patient data and wound images for review by the forward/area trauma team for assessment. The trauma team through a wireless connection with the First Responder guides the procedures necessary to stabilize the patient for evacuation. The First responder system is wirelessly connected to a variety of medical health care sensors for collecting vital information, automatically transmitting the collected data leaving the medic to focus attention to the patient. The two-way wireless communications enables the trauma center to immediately and directly begin treating the patient and to prepare for treatment upon arrival at the trauma center.

MedVizer Mobile Transport System

The Mobile Transport System, developed as part of the US/Norway Contract, continues the direct involvement of the trauma team through the evacuation process by providing a continuous monitoring capability. Real time video with embedded vital signs monitoring data is continuously wirelessly transmitted to the trauma center. Two-way wireless communications is maintained between the evacuation team and the trauma team throughout the transport process insuring that the trauma team is directly and continuously monitoring and directing the treatment and care of the patient. When high-speed wireless digital

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communication is available two-way interactive videoconference is used during the period of transport providing the trauma center specialist the ability to view the patient and guide the functions of the emergency evacuation team.

MedVizer Trauma System

The MedVizer Trauma System was designed to enhance the trauma team's capability of forward/regional emergency medical teams by providing direct access to tertiary level trauma specialist. The system wirelessly collects patient vital signs data, embeds the data into a live continuous video stream enabling the specialist to monitor the patient's condition as he/she guides the treatment procedures. The trauma specialist has full control of the remote video sources enabling them to obtain the view of the patient and the attending physician and guide the treatment application.

ViTelCare Monitoring System

This product was designed and developed for use at a mass casualty collection center. A compact system that could be easily moved within the collection center and that would enable the collection of vital sign data, provide text data entry, still image capture, live interactive video was the objective of this development effort, and communicate across a number of different communication media.

Task 6: Home Land Defense Telemedicine Application Demonstration

The initial plan to implement a telemedicine program utilizing the systems identified in the needs analysis and developed as a result of that assessment was not fully implemented due internal issues and restrictions that limited their full participation. Walker Baptist Hospital did, however, obtain permission to commit personnel and limited resources for a proof of concept project that was limited to 90 days. The proof of concept project was designed by ViTel Net in coordination with the Hospital staff to engage two aspects of the types of systems envisioned to be needed in support of a Home Land Defense event.

A plan was developed to install a trauma system at a small clinic type hospital within the county that was aligned with Walker Baptist. The intent of this project was to enable Trauma Surgeons and ER Specialist at Walker Baptist Hospital to interact with the medical personnel at the remote clinic in emergency situations. In doing so the specialist would provide appropriate guidance and direction to the remote clinical staff to stabilize the patient in preparation for evacuation. In the event of a mass casualty situation the systems would be used by the specialist to guide the clinical staff in treating and triaging the anticipated large numbers of patients that would be arriving at the clinic for treatment. It was anticipated that the data; vital signs, images, video, textual, and audio, transmitted to the trauma center would be used to identify the cause of the mass casualty event. The information could also be sent to state and local agencies as an alert for the type of symptoms that would indicated possible spreading of the mass casualty causal agent.

The plan also included installing a monitoring system at a local elder care facility connected to a care coordination unit within the hospital for use to supplement the on-site staff in caring for the elder patients. In the event of a mass casualty situation it was envisioned that the elder care facility could possibly be a collection center/assembly area expanding the reach of the Walker Baptist staff in treating large numbers of ill personnel. The system would also be used to collect data in an effort to identify and isolate the cause of the mass casualties.

The final element of the plan included a three day demonstration to be conducted during the last week of the pilot project. The purpose of the demonstration was to demonstrate the other products ViTel Net developed in response to those identified during the assessment phase as needed to meet the demands of a mass casualty event. The local emergency response groups and local elected officials, in addition to the hospital staff, will be invited to visit at least one day of the demonstration. In addition to the demonstration of the equipment a briefing of the results of the pilot project and conceptual planning in the event of a mass casualty event will be provided.

Walker Baptist Hospital an affiliate of Baptist Health System was not able to conduct the demonstration project, although all planning and development was completed, as a result of legal issues involving the parent organization, Baptist Health System. The demonstration was however conducted at the Walker Baptist facility.

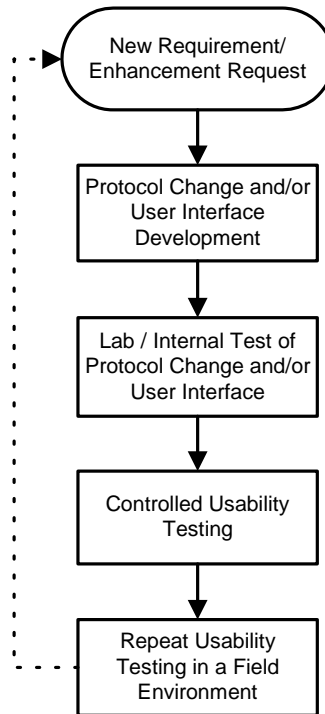## Task 7: Monitoring System for Elder Home Application

Walker Baptist appointed clinical representatives to work with ViTel Net's clinical staff to develop the work flow, clinical application, and assessment protocols that would be used in the senior resident home pilot project. A prototype system integrating the MedVizer tools with commercial off the shelf (COTS) components, computer technology and medical vital sign sensor devices, was completed. It was planned that each patient involved in the pilot program would be issued an identification card; by swiping the card with the integrated card swipe function patient would gain access to their medical record which was stored at a central site. Patients once gaining access to their record would update their vital sign information and provide response to series of questions related to their health condition. The patient was provided an option, when sending their updated information to the central clinical site, to request a video conference with the clinical staff member or just to send the data. If a video conference was requested the Clinical Call Center would be alerted and would establish the call to the patient. The communications between the two sites was to be standard plain old telephone circuits (POTS).

Using the MedVizer tools a standard (COTS) Critcare vital signs monitor and a Cardionics (COTS) electronic stethoscope was integrated with the ViTelCare platform with integrated ViTelCare video conferencing software package. Once a patient registered into the system (card swipe) the system automatically instructed that patient on how to use the medical devices available. It was noted that the stethoscope would not be used unless a videoconference was established by the Clinical Staff.

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A patient questionnaire was designed for completion by either the patient who was automatically transmitted to the clinical call center or to be completed by the clinician based on questions asked of the patient. The questionnaire was used to assess the current condition of the patient. The data at the clinical call center is maintained in a longitudinal format to enable viewing of patient conditions over time. The clinical call center has the capability to forward patient data, as an e-mail attachment, to the attending physician for review and consultation as needed.

To meet the requirements for use in a mass casualty situation the system software allowed an override function that would enable the local (patient) site to create a "new" patient record which was automatically assigned a unique identifier that when sent would notify the clinical staff of a "new" patient. The "new" patient record, with its unique identifier, would be stored in a temporary database to maintain the purity of the original database. The clinician would access the temporary data base and view the patient information. The data could be complied at the clinical call center to show trends over time for a patient and group of patients. This capability was essential in order to capture useful information in a mass casualty situation, such as progression of certain symptoms across a large group of patients. It was envisioned that within a region there would be several casualty collection sites each equipped with one or more monitoring systems connected to the central clinical site for data transfer and video conferencing. To be practical and available to a large population, the goal was to integrate ViTel Net's low bandwidth technology that would enable the accomplishment of the objectives using the standard plain old telephone (POTS) circuit. The technology to be used in such an environment must be very user friendly considering the range of technology awareness that will be exhibited by the potential population.

ViTel Net conducted usability studies using standard methodology to provide on-going product improvement:

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            New Requirement/
            Enhancement Request
                   │
                   ▼
            ┌──────────────────────┐
            │  Protocol Change and/or │
            │   User Interface        │
            │   Development           │
            └──────────────────────┘
                   │
                   ▼
            ┌──────────────────────┐
            │  Lab / Internal Test of │
            │  Protocol Change and/or │
            │   User Interface        │
            └──────────────────────┘
                   │
                   ▼
            ┌──────────────────────┐
            │  Controlled Usability   │
            │   Testing               │
            └──────────────────────┘
                   │
                   ▼
            ┌──────────────────────┐
            │  Repeat Usability       │
            │  Testing in a Field     │
            │  Environment            │
            └──────────────────────┘
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A recent usability study conducted in the controlled lab environment provided usability feedback for systems created with the Medvizer tools. The purpose of the study was to evaluate point of care patient data collection and transfer process using a monitoring unit with multiple sensors and an interface unit. The study evaluated the process using errors as an indicator of process performance. The data collection and transfer process begins with the patient using medical devices that are integrated with the unit to collect physiologic data. The process ends when the data is successfully transferred to the central database on the ViTel Net server. The success of the data collection and transfer process is verified by viewing the data on the server using the Care Coordinator application.

Five volunteer patients were recruited to participate in the study. Demographics of this patient population were consistent with those of the types of targeted users of the monitoring unit. Each patient was given instruction and a demonstration on how to use the medical devices and In Touch unit, and then given the opportunity to practice the entire process before the evaluation started.

Patients were told that the focus of the study was to evaluate the technology, not the patient's performance. The evaluator explained that during the process, she would be recording any difficulties or errors that the patient experienced with the technology. Once the volunteer "patient" said that they understood the tasks they were being asked to perform, the evaluation process began.

During the process the evaluator observed and documented any errors that occurred with the technology in the data collection and transfer process. Once the data was transferred from the In Touch unit, the evaluator verified the successful transfer to the ViTel Net server by accessing and reviewing the patient record using the Care Coordinator software and verifying that all of the data was transferred into the centralized record accurately.

The primary objective was to enable a health care provider to perform all functions remotely to include maintenance of a longitudinal multimedia record for each patient. An additional desired objective was to have the capability of distributing the multimedia patient information to the patient's attending physician for review and possible consultation. The overriding objective was to enable the health care provider to provide equal or better delivery of healthcare to the patient compared to the traditional methodology. It is believed that using the technological approach for providing home health services will result in a reduction of data entry errors occurring during the traditional manual transcription process.

Having completed the requirements assessment the workflow and prototype patient record was modeled using the MedVizer Tools. The model design and prototype was provided to the same health care providers used in the initial assessment for review and comment. Based upon comments received final revisions were completed. The next step involves the integration of a prototype demonstration model. See Task 3 for further discussion.

Task 8: Mobile Transport System

The need for a capability to monitor patients during evacuation, identified in Task 5 above, set the basic requirement for the development of a Mobile Transport Telemedicine System. When it was learned that the Jasper County Alabama Emergency Response Teams would not be able to participate in the research effort ViTel Net begin to look for other interested partners. ViTel Net having a long established relationship with Driscoll Children's Medical Center located in Texas sought their participation in the development and testing of a mobile transport system. Driscoll services a large geographic area in southern Texas frequently air transporting patients from the remote locations to the main Medical Center for treatment. These transports although typically not conducted under emergency situations require continuous monitoring of the patient during the evacuation period. Initially the requirements for the system was to provide the capability to collect patient vital signs during evacuation, transmit the data to the Medical Center's Emergency Room for evaluation, and audio communication between the ER Specialist and the Evacuation Team. The Driscoll Staff in addition to the capability to transmit vital sign data required a system that would enable the transport team to maintain an assessment record of the patient, record of material used during the transport, and other features unique to their application and organizational work flow.

The transport system was 'beta' tested, using simulated vital sign data using an RF communications link. As a result of the beta test, several needed modifications to the

application were identified. Those modifications have been completed and the system is under evaluation, in a simulated environment.

Task 9: MedVizer Trauma System

When it became apparent that Walker Baptist Hospital was not in a position to continue to participate, providing clinical advice, in the development of the Trauma System ViTel Net initiated a research effort with the University of Arizona to provide that capability. The University of Arizona provides medical services with a focus to the remote rural areas, the boarder community. Local hospitals within this area have limited staff and virtually no specialization resulting in the need to transport patients to the University for treatment at an extreme cost to the state. Implementing a remote healthcare delivery system designed specifically for use in the emergency room, enabling local hospitals ER's to connect directly with a trauma specialist at the University would reduce the number of patient transports. The intervention by the trauma specialist would enable the direction of procedures to better stabilize the patient in preparation for transport of those patients that could not be treated remotely.

The University's Director of Trauma provided general requirements for the design of a Trauma System. Most importantly the system had to be user friendly requiring minimum intervention, provide high quality video and audio, integrated continuous vital sign monitoring, and far end camera control. With these basic requirements ViTel Net developed a Trauma System that provided continuous video and vital signs monitoring. The design of the system was verified in a demonstration project at the University and a remote hospital in southern Arizona. Although not designed specifically for use in a mass casualty the system could easily be adapted for that application.

KEY RESEARCH ACCOMPLISHMENTS:

The MedVizer Dvision Tools, a commercial-off-the-shelf (COTS) telemedicine integration tool has proven, within a laboratory environment, to be a rapid integration and configuration telemedicine tool. It has been demonstrated within this environment to be capable of dynamically integrating disparate medical teleconsultation systems, medical information and image display modalities, and electronic legacy hospital information systems within a wired and wireless environment.

REPORTABLE OUTCOMES:

The series of demonstration projects have proven the capability of the MedVizer tools for rapid prototyping of systems for specific applications. All of the products are set up in the ViTel Net demonstration site with connectivity to DoD Hospital Information Systems (ICDB and CHCSII).

CONCLUSIONS:

Execution of the research plan should be applied to specific worthy projects wherein proof of concept applications can be tested and evaluated in military and commercial healthcare systems, which will demonstrate task accomplishments. Each of these projects will have an associated report.

REFERENCES:

References will be provided in project reports.